DRIVING CIRCUIT INCLUDING ORGANIC ELECTROLUMINESCENT ELEMENT, ELECTRONIC EQUIPMENT, AND ELECTRO-OPTICAL DEVICE

BACKGROUND OF THE INVENTION

1. Field of Invention

[0001] The present invention relates to a driving circuit for driving an active-matrix display device employing organic electroluminescent elements, and electronic equipment and an electro-optical device, incorporating the driving circuit, and, more particularly, to a driving circuit having the function of applying a reverse-bias voltage to an organic electroluminescent element for controlling degradation of the organic electroluminescent element, and electronic equipment and an electro-optical device, incorporating the driving circuit.

2. Description of Related Art

[0002] It is known that an organic EL display device is produced by arranging a plurality of pixels of organic electroluminescent elements, i.e., one of electro-optical elements, in a matrix. The organic electroluminescent element includes a metal electrode of Mg:Ag or Al:Li, etc., as a cathode, a transparent electrode such as an ITO (Indium Tin Oxide) as an anode, and an organic thin-film laminate, including an emission layer, interposed between the cathode and the anode.

[0003] FIG. 9 shows a typical construction of a driving circuit for an active matrix display device employing an organic electroluminescent element. Referring to FIG. 9, the organic electroluminescent element is shown as a diode 10. The driving circuit is composed of transistors Tr 1 and Tr 2, each constructed of a thin-film transistor (TFT), and a capacitive element 2 storing charge.

[0004] Both the transistor Tr 1 and the transistor Tr 2 are of a p-channel TFT. The conduction state of the transistor Tr 1 is controlled in response to a charge stored in the capacitive element 2 as shown. The capacitive element 2 is charged through a data line V_{DATA} by the transistor Tr 2, which is turned on with a selection voltage V_{SEL} driven low. When the transistor Tr 1 is turned on, a current flows through the electroluminescent element 10 from the transistor Tr 1. With the current flowing therethrough, the electroluminescent element 10 continuously emits light.

[0005] FIG. 10 shows a simple timing diagram for the circuit shown in FIG. 9. When data is written, the selection voltage V_{SEL} is driven low as shown FIG. 10. The transistor Tr 2 is turned on, thus charging the capacitive element 2. The charge duration is a write period T_W. An actual presentation period follows the write

period T_W. During the presentation period, charge stored in the capacitive element 2 controls the conduction state of the transistor Tr 1. The presentation period is represented by T_H as shown.

[0006] FIG. 11 shows another arrangement of the organic electroluminescent element driving circuit. The driving circuit shown is described in a paper entitled "The Impact of Transient Response of Organic Light Emitting Diodes on the Design of Active Matrix OLED Displays" (1998 IEEE IEDM98-875). Referring to FIG. 11, there are shown a driving transistor Tr 1, a charge control transistor Tr 2, a first selection transistor Tr 3, and a second selection transistor Tr 4 which is turned off during a charging period of the capacitive element 2.

[0007] As is well known, transistors, even complying with the same specifications, suffer variations in performance. Even when the same voltage is applied to the gates of transistors, these transistor do not necessarily permit current of equal values to flow therethrough. Such variations cause nonuniformity in brightness. In the driving circuit, a current source 4 feeds a write current corresponding to a data signal, and the data signal thus controls the gate voltage of the transistor. In this way, the emission state of the organic electroluminescent element is controlled.

[0008] Transistors Tr 1 through Tr 4 are all of a p-type channel transistor. When the selection voltage V_{SEL} is driven low, the transistors Tr 2 and Tr 3 are turned on, thereby storing in the capacitive element 2 a charge corresponding to the value of the output of the current source 4. When the selection voltage V_{SEL} is driven high, the transistors Tr 2 and Tr 3 are turned off. The conduction state of the transistor Tr 1 is thus controlled by the charge stored in the capacitive element 2. With a data hold control signal V_{gp} turning on the transistor Tr 4, an electroluminescent element 10 is supplied with a current corresponding to the charge stored in the capacitive element 2. This duration of time is a presentation period T_H.

[0009] FIG. 12 shows a simple timing diagram of the circuit shown in FIG. 11. When data writing is performed by the current source 4 as shown in FIG. 12, the selection voltage V_{SEL} is driven low, thereby turning on the transistors Tr 2 and Tr 3. The capacitive element 2 is thus charged. The charge period equals a write period T_W. With the selection voltage V_{SEL} driven high, the transistors Tr 2 and Tr 3 are turned off. With the data hold control signal V_{gp} driven low, the conduction state of the transistor Tr 1 is determined based on the charge stored in the capacitive element 2. The electroluminescent element 10 is supplied with a current

corresponding to the charge stored in the capacitive element 2. This duration of time is a presentation period T_H.

[0010] FIG. 13 shows another driving circuit of an organic electroluminescent element. The driving circuit shown here is disclosed in Japanese Unexamined Patent Application Publication No. 11-272233. As shown, the driving circuit includes a driving transistor Tr 1 which supplies an electroluminescent element 10 with a current from a power source during the on state thereof, a capacitive element 2 which stores a charge for controlling the conduction state of the transistor Tr 1, and a charge control transistor Tr 5 which controls the charging of the capacitive element 2 in response to an external signal. A voltage V_{rscan} is driven low to turn off a charge control transistor Tr 7 to cause the electroluminescent element 10 to emit light, and then, a reset signal V_{rsig} is not output. A transistor Tr 6 is included for adjustment purposes.

[0011] When the electroluminescent element 10 emits light in the driving circuit, the transistor Tr 5 is turned on, and the capacitive element 2 is charged by a transistor Tr 6 through a data line V_{DATA}. Conductance between the source and drain of the transistor Tr 1 is controlled in response to a charge level of the capacitive element 2 to allow a current to flow through the electroluminescent element 10. Referring to FIG. 14, when the voltage V_{SCAN} is driven high to turn on the transistor Tr 5, the capacitive element 2 is charged through the transistor Tr 6. Conductance between the source and drain of the transistor Tr 1 is controlled in response to a charge level of the capacitive element 2 to allow a current to flow through the electroluminescent element 10.

[0012] Reverse-biasing the organic electroluminescent element is known as an effective means to prolong the service life of the organic electroluminescent element. For example, Japanese Unexamined Patent Application Publication No. 11-8064 discloses a technique for prolonging the service life of the organic electroluminescent element.

[0013] To reverse-bias the organic electroluminescent element using the disclosed technique, an additional power source for a negative voltage needs to be prepared and controlled to reverse-bias the organic electroluminescent element.

[0014] It is an object of the present invention to provide a driving circuit, for driving an organic electroluminescent element, which supplies the organic electroluminescent element with a reverse bias without involving an increase in power

consumption and a cost increase, and to provide electronic equipment, and an electro-optical device.

SUMMARY OF THE INVENTION

[0015] A first driving circuit of the present invention drives an organic electroluminescent display device in which a plurality of pixels, each containing an organic electroluminescent element, is arranged in a matrix, and the first driving circuit includes a reverse-bias setting circuit which sets the organic electroluminescent elements in a reverse-bias state on an area-by-area basis.

[0016] A second driving circuit of the present invention drives an organic electroluminescent display device in which a plurality of pixels, each containing an organic electroluminescent element, is arranged in a matrix, and the second driving circuit includes a reverse-bias setting circuit which sets organic electroluminescent elements contained in a predetermined area, from among the organic electroluminescent elements, in a reverse-bias state.

[0017] In a third driving circuit of the present invention, the reverse-bias setting circuit includes a switch which switches an electrical connection state of at least one of electrodes of each of the organic electroluminescent elements between being connected to a first power source line for supplying a first voltage and being connected to a second power source line for supplying a second voltage that is lower in level than the first voltage.

[0018] Since the switch is used to switch the connection state of the driving circuit between being connected to a first power source and a second power source, no additional power is required. Without involving an increase in power consumption and a cost increase, a reverse-bias is supplied to the organic electroluminescent element. In this case, typically, the first power source is Vcc, and the second power source is ground (GND). These are existing power sources. The present invention is not limited to this arrangement, as long as a voltage difference large enough to cause the organic electroluminescent element to emit light is used.

[0019] In a fourth driving circuit of the present invention, the reverse-bias setting circuit includes a switch which switches an electrical connection state of a cathode of each of the organic electroluminescent elements between being connected to a first power source line for supplying a first voltage and being connected to a second power source line for supplying a second voltage that is lower in level than the first voltage.

[0020] In a fifth driving circuit of the present invention, the switches are arranged with one switch for each pixel, and the organic electroluminescent elements are set to be in a reverse-bias state on a pixel-by-pixel basis by controlling the switches.

[0021] In a sixth driving circuit of the present invention, the switches are arranged with one switch for each line of pixels, and the organic electroluminescent elements are set to be in a reverse-bias state on a line-by-line basis by controlling the switches.

[0022] In a seventh driving circuit of the present invention, the switch is arranged with the single switch for all pixels, and the organic electroluminescent elements of all pixels are set to be in a reverse-bias state by controlling the switch.

[0023] In an eighth driving circuit of the present invention, the switches are arranged with one switch for each of particular pixels, and the organic electroluminescent elements of the particular pixels are set to be in a reverse-bias state by controlling the switches.

[0024] A ninth driving circuit of the present invention drives an electro-optical device in which a plurality of electro-optical elements is arranged in a matrix, and includes a reverse-bias setting circuit which sets at least one of the electro-optical elements in a reverse-bias state.

[0025] First electronic equipment of the present invention includes an active-matrix display device including the driving circuit.

[0026] A first electro-optical device of the present invention includes a driving circuit for actively driving a display device in which a plurality of pixels, each including an electro-optical element, is arranged in a matrix, and the driving circuit includes a reverse-bias setting circuit which sets the electro-optical elements in a reverse-bias state on an area-by-area basis.

[0027] A second electro-optical device of the present invention includes a driving circuit for driving a display device in which a plurality of pixels, each including an electro-optical element, is arranged in a matrix, and the driving circuit includes a reverse-bias setting circuit which sets electro-optical elements contained in a predetermined area, from among the electro-optical elements, in a reverse-bias state.

[0028] In a third electro-optical device of the present invention, the reverse-bias setting circuit includes a switch which switches an electrical connection state of at least one of electrodes of each of the electro-optical elements between

being connected to a first power source line for supplying a first voltage and being connected to a second power source line for supplying a second voltage that is lower in level than the first voltage.

[0029] In a fourth electro-optical device of the present invention, the reverse-bias setting circuit includes a switch which switches an electrical connection state of a cathode of each of the electro-optical elements between being connected to a first power source line for supplying a first voltage and being connected to a second power source line for supplying a second voltage that is lower in level than the first voltage.

[0030] In a fifth electro-optical device of the present invention, the switches are arranged with one switch for each pixel, and the electro-optical elements are set to be in a reverse-bias state on a pixel-by-pixel basis by controlling the switches.

[0031] In a sixth electro-optical device of the present invention, the switches are arranged with one switch for each line of pixels, and the electro-optical elements are set to be in a reverse-bias state on a line-by-line basis by controlling the switches.

[0032] In a seventh electro-optical device of the present invention, the switch is arranged with the single switch for all pixels, and the organic electroluminescent elements of all pixels are set to be in a reverse-bias state by controlling the switch.

[0033] In an eighth electro-optical device of the present invention, the switches are arranged with one switch for each of particular pixels, and the electro-optical elements of the particular pixels are set to be in a reverse-bias state by controlling the switches.

[0034] A ninth electro-optical device of the present invention includes a driving circuit for driving a matrix of electro-optical elements, wherein the driving circuit includes a reverse-bias setting circuit which sets at least one of the plurality of electro-optical elements in a reverse-bias state on an area-by-area basis.

[0035] In a tenth electro-optical device of the present invention, the electro-optical element is an organic electroluminescent element.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] FIG. 1 is a block diagram showing a driving circuit for driving organic electroluminescent elements in accordance with one embodiment of the present invention.

FIG. 2 is a block diagram showing the construction of the organic electroluminescent element driving circuit of the present invention.

FIG. 3 is a cross-sectional view of a pixel circuit in the organic electroluminescent element driving circuit of the present invention.

FIG. 4 is a block diagram showing another arrangement of the organic electroluminescent element driving circuit of the present invention.

FIG. 5 is a block diagram showing still another arrangement of the organic electroluminescent element driving circuit of the present invention.

FIG. 6 is a waveform diagram showing the operation of the organic electroluminescent element driving circuit of the present invention.

FIG. 7 is a block diagram showing another embodiment of the organic electroluminescent element driving circuit of the present invention.

FIG. 8 is a block diagram showing still another embodiment of the organic electroluminescent element driving circuit of the present invention.

FIG. 9 is a block diagram showing the construction of a conventional organic electroluminescent element driving circuit.

FIG. 10 is a waveform diagram showing the operation of the organic electroluminescent element driving circuit shown in FIG. 9.

FIG. 11 is a block diagram showing the construction of another conventional organic electroluminescent element driving circuit.

FIG. 12 is a waveform diagram showing the operation of the organic electroluminescent element driving circuit shown in FIG. 11.

FIG. 13 is a block diagram showing the construction of yet another conventional organic electroluminescent element driving circuit.

FIG. 14 is a waveform diagram showing the operation of the organic electroluminescent element driving circuit shown in FIG. 13.

FIG. 15 is a perspective view showing the construction of a mobile personal computer as one example of electronic equipment that incorporates an active-matrix display device including a driving circuit of one embodiment of the present invention.

FIG. 16 is a perspective view showing the construction of a mobile telephone as one example of the electronic equipment that incorporates an active-matrix display device including a driving circuit of one embodiment of the present invention.

FIG. 17 is a perspective view showing the construction of a digital still camera as one example of the electronic equipment that incorporates an active-matrix display device including a driving circuit of one embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0037] The embodiments of the present invention will now be discussed, referring to the accompanying drawings. Like components are identified with like reference numerals throughout the drawings.

(1) Application of a reverse-bias voltage to a conventional driving circuit

1) Application of a reverse-bias voltage to the circuit shown in FIG. 9

[0038] FIG. 2 is a circuit diagram showing one embodiment of a driving circuit for an active-matrix display device that incorporates organic electroluminescent elements. Referring to FIG. 2, the organic electroluminescent element driving circuit of this embodiment includes a switch 20 which switches the connection of the cathode of each organic electroluminescent element from a second potentialpotential (GND) to a first potentialpotential (Vcc). To cause the organic electroluminescent element 10 to emit light, the switch 20 is simply connected to the second potentialpotential (Vcc). This state is identical to the state shown in FIG. 9.

[0039] To apply a reverse bias to the organic electroluminescent element 10, the transistor Tr 1 is turned off and the switch 20 is set to connect the organic electroluminescent element 10 to the first potentialpotential (Vcc). Since the anode of the organic electroluminescent element 10 cannot be higher than the first potential (Vcc), the organic electroluminescent element 10 is reverse-biased.

[0040] When the parasitic capacitance C of the anode of the organic electroluminescent element 10 is small, the anode of the organic electroluminescent element 10 rises in potential in response to a potential change in the cathode of the organic electroluminescent element 10, i.e., a potential rise from the second voltage (GND) to the first voltage (Vcc). As a result, the organic electroluminescent element 10 can not be applied with a sufficient reverse-bias voltage. To apply a sufficient reverse-bias voltage, a potential rise in the anode side must be restricted. Increasing a wiring parasitic capacitance C on the anode side is contemplated as a means to control the potential rise. A large reverse-bias voltage can be applied by increasing the

parasitic capacitance C on the anode side, and degradation of the organic electroluminescent element 10 is thus effectively controlled.

[0041] A method of increasing the parasitic capacitance on the anode will now be discussed, referring to FIGS. 3(a)-3(b). A typical cross-sectional construction of the organic electroluminescent element is first discussed, referring to FIG. 3(a).

[0042] A semiconductor thin film is formed on a glass substrate 81. A source region 82 and a drain region 85 of a transistor are formed within the semiconductor thin film. A gate insulator layer 83 covers the source region 82 and the drain region 85 of the transistor. A gate electrode 84 is formed on the gate insulator layer 83. A first interlayer insulator 86 covers the gate electrode 84 and the gate insulator layer 83. Connection holes are drilled in the gate insulator layer 83 and the first interlayer insulator 86. The source region 82 and the drain region 85 are respectively connected to a source electrode 87 and a drain electrode 91 by filling the respective connection holes with an electrically conductive material. A second interlayer insulator 88 covers the source electrode 87, the drain electrode 91, and the first interlayer insulator 86. The drain electrode 91 is connected to an organic thin-film laminate, including an emission layer 95, through the anode 89 constructed of ITO. The organic thin-film laminate includes at least a hole injection layer 93 and the emission layer 95. A cathode 97 of the organic electroluminescent element is formed on the organic thin-film laminate. The switch 20 switches the potential of the cathode 97 from the second potential (GND) to the first potential (Vcc).

[0043] The method of increasing the parasitic capacitance on the anode will now be detailed.

(i) Parasitic capacitance between the source electrode and the drain electrode

[0044] A conductive member is arranged in the vicinity of wiring between the anode 89 of the organic electroluminescent element and the transistor to form a parasitic capacitance to the wiring. Specifically, referring to FIG. 3(b), the parasitic capacitance C is increased by setting the separation between the source electrode 87 and the drain electrode 91 to be narrower than a typical distance, or by setting facing areas of these electrodes to be larger than the remaining areas. In other words, the parasitic capacitance C is set up between the source electrode and the drain electrode of the driving transistor.

(ii) Parasitic capacitance with a metal layer arranged within the insulator

[0045] Referring to FIG. 3(c), a metal layer 92 is arranged within the first interlayer insulator 86 to increase a parasitic capacitance between the metal layer 92 and the drain electrode 91. Specifically, the parasitic capacitance C is set up between the metal layer 92 arranged within the first interlayer insulator 86 and the drain electrode 91.

[0046] By simply resetting the switch 20, the organic electroluminescent element is put into an emission state or a reverse-bias state. No extra negative-voltage power source is required. This arrangement involves neither increase in power consumption nor additional space requirement. The switch 20 is easily constructed by combining a transistor.

2) Application of a reverse-bias voltage in the circuit shown in FIG. 11

[0047] Referring to FIG. 4, the switch 20 is connected to the cathode of the organic electroluminescent element 10. When the switch 20 is turned to the first potential (Vcc) from the second potential (GND), the organic electroluminescent element 10 is set to be in the reverse-bias state using the parasitic capacitance in the same way as in the circuit shown in FIG. 2.

3) Application of a reverse vias voltage in the circuit shown in FIG. 13

[0048] The above-mentioned driving circuit shown in FIG. 13 may include the switch 20 to the cathode of the organic electroluminescent element 10 in the same way as in the circuit shown in FIG. 5. The switch 20 switches the cathode of the organic electroluminescent element from the first potential (Vcc) to the second potential (GND). Using the parasitic capacitance C, the organic electroluminescent element 10 is easily put into the reverse-bias state.

(2) Application of a reverse-bias voltage to a predetermined group of pixels

[0049] When a display device is constructed of the organic electroluminescent elements, the organic electroluminescent element corresponds to a single pixel. In the arrangements shown in FIG. 2 through FIG. 5, a switch is required for each organic electroluminescent element, i.e., for each pixel.

1) Application of a reverse-bias voltage to each pixel

[0050] FIG. 1 shows the connection of pixel circuits 1-1, 1-2, ..., each having the respective organic electroluminescent element, with the corresponding switches 20-1, 20-2, ...

[0051] As shown, the pixel circuit 1-1 having the respective organic electroluminescent element is provided with the switch 20-1, and the pixel circuit 1-2

is provided with the switch 20-2. Specifically, one pixel has its own switch having the above-referenced structure. These switches are respectively controlled by control signals S1 and S2. The control signals are input for a period of time except a duration of time during which the capacitor in each pixel circuit is charged and except a duration of time during which the organic electroluminescent element 10 emits light, thereby controlling the respective switches. In the embodiment shown in FIG. 4, a control signal S is easily generated referencing the selection voltage V_{SEL} that determines the write period T_W and the data hold control signal V_{gp} that determines the display period T_H. Specifically, as shown in FIG. 6(a), the time other than the write period T_W determined by the selection voltage V_{SEL} and the display period T_H determined by the data hold control signal V_{gp} becomes a reverse-bias period T_B.

2) Application of a reverse-bias voltage to each line

[0052] The above-referenced switch may be arranged for each line of pixels forming a display screen. Referring to FIG. 7, a switch 20-1 is arranged so that it is shared by pixel circuits 1-11, 1-12, ... and a switch 20-2 is arranged so that it is shared by pixel circuits 1-21, 1-22, ... When one switch is arranged for each line, the number of switches is smaller than in the circuit shown in FIG. 1. It is possible to reduce costs.

[0053] If the pixels are reverse-biased on a line-by-line basis as shown in FIG. 6(b), a given line of pixels is in the reverse-bias period T_B, and the remaining lines of pixels are in either write period T_W or the display period T_H. Since a plurality of lines forming the display screen is provided with the respective switches, the pixels are periodically set to be in the reverse-bias state on a line-by-line basis. The service life of the organic electroluminescent element is thus prolonged.

[0054] In the pixel circuit that permits the reverse-bias period T_B and the write period T_W to concurrently take place as shown in FIG. 6(c), a given line may be in the reverse-bias period T_W or the write period T_W, and the remaining lines may be in the display period T_H.

3) Concurrent application of a reverse bias to all pixels

[0055] A single switch is arranged for all pixels forming the display screen. By controlling the switch, the organic electroluminescent elements for all pixels forming the display screen are concurrently put into the reverse-bias state. Referring to FIG. 8, a single switch 20 is shared by pixel circuits 1-11, 1-12, ..., and pixel circuits 1-21, 1-22, ..., and the switch 20 concurrently sets all pixels to be in the

reverse-bias state. When the single switch is shared by all pixels, the number of switches is minimized, which makes it possible to reduce costs.

[0056] When all pixels are concurrently set to be in the reverse-bias state as shown in FIG. 6(d), the time length of the reverse-bias period T_B is set so that the write period T_W and the display period T_H equal each other in one frame period F. Referring to FIG. 6(d), the reverse-bias period T_B comes first at the beginning of the frame period, followed by the write period T_W and the display period T_H. Alternatively, the reverse-bias period T_B may be at any position within the frame period F.

4) Application of a reverse-bias voltage to particular pixels only

[0057] If a color display device employs the organic electroluminescent elements, particular organic electroluminescent materials for emitting light of different colors such as red, green, and blue may be used. When different organic electroluminescent materials are employed, there occurs a difference in service life therebetween. When the display device is constructed of a plurality of organic electroluminescent materials, any organic electroluminescent material having the shortest service life determines the service life of the display device. Reverse-biasing the particular pixels only is thus contemplated. In this case, the following two methods are available. (i) Only organic electroluminescent elements for the pixels having shorter life are reverse-biased. (ii) The number of times a reverse bias is applied to the organic electroluminescent elements for the pixels having shorter life is set to be larger than the number of times the remaining organic electroluminescent elements will be reverse-biased. In this way, the service life of the entire display screen can be prolonged.

[0058] Some organic electroluminescent display device produces an area display that is presented on a portion of the display screen in a particular color, such as orange, blue, green, etc. In such a display device, only the organic electroluminescent elements having [shorter]the shortest display life area may be reverse-biased. In this way, the service life of the display screen can be prolonged.

[0059] The driving circuit for the active-matrix display device that uses the organic electroluminescent elements has been discussed. The present invention is not limited to this type of display device only. For example, the present invention may be applied to an active-matrix display device employing an electro-optical element, other than the organic electroluminescent element, such as a TFT-LCD, an

FED (Field Emission Display), an electrophoresis element, an electric field reversing element, a laser diode, or an LED.

[0060] Several pieces of electronic equipment incorporating the active-matrix display device including the above-referenced driving circuit 1 will now be discussed. FIG. 15 shows a perspective view showing the construction of a mobile personal computer 1100 incorporating the active-matrix display device. As shown, the personal computer 1100 includes a main unit 1104 with a keyboard 1102, and a display unit 1106. The display unit 1106 includes the active-matrix display device 100

[0061] FIG. 16 is a perspective view showing the construction of a mobile telephone 1200 which incorporates the active-matrix display device 100 including the above-referenced driving circuit. As shown, the mobile telephone 1200 includes a plurality of control buttons 1202, an ear piece 1204, a mouth piece 1206, and the active-matrix display device 100.

[0062] FIG. 17 is a perspective view showing the construction of a digital still camera 1300 which incorporates the active-matrix display device 100, including the above-reference driving circuit, as a viewfinder. A simplified diagram of connections with external devices is also shown here. In contrast with a silver-film camera that exposes a film to an optical image of an object, the digital still camera 1300 generates a video signal by photoelectrically converting an optical image of an object through an image pickup device such as a CCD (Charge-Coupled Device). The above-referenced active-matrix display device 100 is mounted on the back of a case 1302 of the digital still camera 1300. The active-matrix display device 100 functions as a view finder to display the image of the object. Arranged on the front of the case 1302 (the far side of the case 1302 in FIG. 17) is a photodetector unit 1304 including an optical lens and the CCD.

[0063] When a photographer presses a shutter button 1306 after recognizing the image of an object displayed on the active-matrix display device 100, the image taken by the CCD at the moment is transferred to and stored in a memory on a circuit board 1308. The digital still camera 1300 is provided on the side of the case 1302 with a video signal output terminal 1312 and an input/output terminal 1314 for data exchange. As shown, as required, a television monitor 1430 is connected to the video signal output terminal 1312, and a personal computer 1440 is connected to the input/output terminal 1314 for data exchange. In response to predetermined

operational steps, the video signal stored in the memory of the circuit board 1308 is output to the television monitor 1430 and the personal computer 1430.

[0064] Besides the personal computer shown in FIG. 15, the mobile telephone shown in FIG. 16, and the digital still camera shown in FIG. 17, the electronic equipment to which the active-matrix display device 100 of the present invention is applied may be any of a diversity of electronic equipment including a liquid-crystal display television, a viewfinder type or direct monitoring type video cassette recorder, a car navigation system, a pager, an electronic pocketbook, an electronic tabletop calculator, a word processor, a workstation, a video phone, a POS terminal, and an apparatus having a touch panel. The above-referenced active-matrix display device 100 is used as a display unit in each of the above electronic equipment.

[Advantages]

[0065] In accordance with the present invention, the organic electroluminescent elements are set to be in the reverse-bias state on the basis of a group of predetermined pixels at a time, and the reverse-bias voltage can be applied without involving an increase in power consumption and an increase in layout space requirement. The service life of the organic electroluminescent element can be thus prolonged. Using the parasitic capacitance, the reverse-bias voltage can be applied without the need for an additional power source. The service life of the organic electroluminescent element can be further prolonged.